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PATENTS ACT, 1977

IN THE MATTER OF European Patent Application No. 97106052.0 filed on 12 April 1997 by Bayerische Motoren Werke AG

I, Francis Willoughby John HUMPHRIES, Technical Translator, of 70 Hungerford Road, London, N7 9LP, do hereby declare that I am familiar with the English and German languages and that the attached English text is a true and correct translation into the English language of the "Druckexemplar" specification in German as accepted for grant by the European Patent Office in respect of the above-mentioned European patent application, now Patent No. 0,806,553

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The invention according to the preamble of claim 1 is based on EP-A-0 405 310.

This document discloses a method of regenerating a soot filter in the exhaust system of a diesel engine. An oxidation catalyst is associated with the soot filter, near thereto and upstream thereof, and its conversion temperature is increased in controlled manner in dependence on the soot load on the soot filter, by fuel additionally injected upstream of the catalyst in order to increase the conversion rate, so that the ignition temperature of diesel soot (about 600°C) is reliably reached at relatively low exhaust temperatures.

As is known, when diesel soot travels through a conventionally operating catalyst, a considerable proportion of the accumulated, highly volatile hydrocarbon compounds are extracted, so that the soot deposited in the filter is relatively dry and difficultly inflammable in spite of additives. In the known method, the excess hydrocarbon components formed during the conversion, increased by adding the fuel, are supplied to the soot deposited in the filter, with the result that the soot ignition temperature is advantageously influenced but not to a desirable extent.

The object of the invention therefore is to improve the method described in the preamble of claim 1, using the disclosed means, so that the soot retained the filter is substantially always at its minimum ignition temperature for burning off.

This problem is addressed by claim 1, in that a liquid fuel is supplied under open-loop/closed-loop control at a temperature about 30 – 60% in degrees Celsius below the respective normal maximum catalyst conversion temperature and in a quantity such that the soot in the soot filter is moistened.

The advantage of the invention is considerable reduction of the ignition temperature, safe burning-off of soot, and also the fact that the catalyst can be placed at any desired position between the soot filter and the diesel engine, since moistening the soot advantageously obviates the need for heating the soot filter by a catalyst in the immediate neighbourhood.

For effective soot moistening, according to a feature of the invention the introduction of fuel into the exhaust system begins below the starting temperature of the catalyst, since as a result the proportion of fuel added for soot moistening is relatively high, with or without a catalyst upstream of the soot filter.

The invention provides an advantageous means of introducing the fuel into the soot filter and/or into the exhaust system upstream of the soot filter.

The invention has the additional advantage that the place where fuel is introduced can be chosen irrespective of the catalyst arrangement in the exhaust system, the fuel being injected by a separate device. Finally the cycles of soot moistening can be controlled by a performance graph in dependence on parameters of the soot filter, the exhaust gas and other engine parameters, resulting in minimum fuel consumption and optimum burning-off of soot.

The invention will now be described.

In a method of purifying the exhaust gas of diesel engines, the exhaust gas in an exhaust system flows through an oxidation catalyst and/or an SCR or denox catalyst and a soot filter. In order to increase the proportion of hydrocarbons in the soot in the soot filter, a liquid fuel is introduced at a controlled temperature into the exhaust system. As is known, when diesel soot travels through a conventionally operating catalyst, the conversion results in withdrawal of highly volatile hydrocarbon compounds. Accordingly, the aim of controlled fuel introduction according to EP-A-0 405 310 from which the preamble is taken, is to apply gaseous hydrocarbon compounds to the soot in the filter downstream of the catalyst, in order to reduce the soot ignition temperature. The conversion heat from the appropriately-constructed catalyst, disposed near to and upstream of the soot filter, contributes substantially towards igniting the soot.

According to the invention, in order reliably to ignite the soot deposited in the filter while simultaneously uncoupling the disadvantageous structural combination of the catalyst and the soot filter, according to the invention the method of exhaust-gas purification is improved in that the fuel is introduced under open-loop/closed-loop control, up to a temperature about 30 – 60% lower in degrees Celsius than the normal maximum permissible catalyst conversion temperature, in a proportion such that the soot in the soot filter is moistened.

To obtain effective soot moistening after predetermined soot ignition, introduced under closed-loop/open-loop control for burning off the soot filter with minimum fuel consumption, the introduction of fuel into the exhaust system begins considerably below the starting temperature of the catalyst; the upper limit for introduction can e.g. be the starting temperature plus about 200°C.

In an advantageous construction using a separate known fuel-injecting device, the invention enables the fuel to be introduced directly into the soot filter and/or into the exhaust system upstream of and near the filter. In this method the introduced fuel need not be conveyed through any of the designated catalysts, individually or in combination, and the advantageous result is minimum consumption of additional fuel. In a diesel engine the fuel is preferably the fuel for the engine.

Advantageously the soot ignition cycles and the associated burning-off of soot are controlled in accordance with a performance graph. The function-dependent parameters can be intervals between loading, dependent on the distance travelled, and/or the exhaust temperature and/or the filter counterpressure and/or other engine parameters.

The method according to the invention is especially advantageous when operating with an oxidation catalyst and/or an SCR catalyst with an incorporated oxidation catalyst upstream of the soot filter and disposed near the engine in an exhaust system into which the soot-moistening fuel is injected by a separate device downstream of the catalyst and near or into the soot filter. The catalyst is disposed

near the engine, resulting in a high conversion rate and an advantageous increase in the exhaust temperature upstream of the moistened soot filter, with the advantageous result of additively supported regeneration of the soot filter system even at lower loads.

By controlled soot conditioning according to the invention, the regeneration range of additive filter systems can advantageously be extended to the entire engine operating range, with the further advantage of substantially reducing the energy consumed for regeneration as compared with filter systems using external regeneration energy.

If an SCR or denox catalyst is disposed downstream of a soot filter which, as is known, has a high heat capacity at reduced exhaust-gas temperatures, the exhaust-gas temperature curve in front of the catalyst can be better adapted to the operating range of a conventional Pt/Al_2O_3 denox catalyst.

CLAIMS

1. A method of purifying the exhaust gas on diesel engines,
   - wherein the exhaust gas in an exhaust-gas system flows through an oxidation catalyst and/or an SCR catalyst (denox cat.) and a soot filter and
   - a suitable fuel is supplied in temperature-controlled manner to the exhaust-gas system in order to increase the proportion of hydrocarbons,

   characterised in that
   - an oxidation catalyst and/or an SCR catalyst with an incorporated oxidation catalyst are operated in the exhaust-gas system upstream of the soot filter and relatively near the engine,
   - a liquid fuel is introduced into the soot filter and/or into the exhaust-gas system upstream of the soot filter but downstream of the respective catalyst, and
   - the fuel is introduced under open-loop/closed-loop control, up to a temperature about 30 – 60% lower in degrees Celsius than the normal maximum permissible catalyst conversion temperature, in a proportion such that the soot in the soot filter is moistened.

2. A method according to claim 1, characterised in that the introduction of fuel into the exhaust system begins below the starting temperature of the respective catalyst, or not more than about 200°C above the starting temperature.

3. A method according to claims 1 and 2, characterised in that the fuel is injected by a separate device.

4. A method according to one or more of claims 1 to 3, characterised in that if required an oxidation catalyst or an SCR catalyst with an incorporated

oxidation catalyst is additionally operated in the exhaust system downstream of the soot filter.

5. A method according to one or more of claims 1 to 4, characterised in that cycles of soot moistening are controlled in accordance with a performance graph in dependence on loading intervals and/or the exhaust-gas temperature and/or the filter counter-pressure and/or engine parameters.